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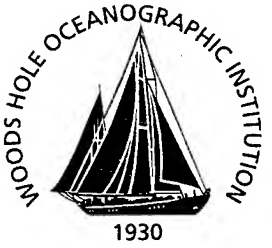

Numbers of Calling Whales in the North Pacific

by

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Technical Report

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John Stegeman, Chair

Department of Biology

NUMBERS OF CALLING WHALES IN THE NORTH PACIFIC

William A. Watkins, Mary Ann Daher, and Joseph E. George

Support is from CNO N45 Environmental Program and U.S. Army Corps of Engineers (DCA87-00-H-0026) with funding from the Department of Defense Legacy Resource Management Program.

Key words -- Numbers of calling whales, North Pacific whales, SOSUS arrays monitor whales, Seasonal distribution of North Pacific whales, Hydrophone array monitoring of whales.

CONTENTS

ABSTRACT

Since November 1995, the U.S. Navy's Sound Surveillance System (SOSUS) and other hydrophone arrays were used to regularly sample the occurrence of whale sounds in four Regions bordering the continental margins across the North Pacific. The numbers of whales heard calling varied with season and location for each species, blue whales (*Balaenoptera musculus)*, fin whales (*Balaenoptera physalus*), and humpback whales (*Megaptera novaeangliae*). For blue whales, calling during the Fall season averaged 5 whales per event, Winter averaged 1.5 whales per event, Spring averaged 1 whale, and Summer averaged 1.5 whales. For fin whales, the numbers of whales heard ("F" calls from individuals) during Winter averaged 3 whales per event, Spring and Fall calling averaged 1.5 whales, and Summer averaged 1 whale. The "J" calling events, regardless of season, were judged to be from at least 6 fin whales. Humpback singing typically was from 3 whales. These numbers demonstrated seasonal variations in calling whales for each Region.

INTRODUCTION

The development of realistic assessments for the number of whales that are likely to be calling during a given period in the deep ocean requires long-term acoustic sampling, broad area coverage, and consistent methods of counting. The whale call monitoring program using hydrophone systems in deep water has fulfilled these requirements (Watkins et al. 2000a).

Since November 1995, acoustic data from the U.S. Navy's Sound Surveillance System (SOSUS) and other arrays have been regularly sampled to assess the extent of whale calling in four Regions bordering the continental margins across the North Pacific (Watkins et al. 2000b). This monitoring program has continued systematically over the past five and a half years, providing long-term data on the occurrence of calling by whales. The deepwater hydrophone systems allow relatively long-range listening, permitting coverage of broad regions of the ocean. Recognition of the characteristic call patterns produced by the different species allowed calls of individual whales to be systematically identified and realistic assessments made of the numbers of whales heard calling.

Previous descriptions of the occurrence of calling whales

across the North Pacific have included the following reports: the seasonal presence of calling blue, fin, and humpback whales were described for different North Pacific Regions from the 1996 and 1997 monitoring program data (Watkins et al. 2000a), the monthly occurrence of calling by the different species on different hydrophone arrays and the location of individual calling whales were identified from the data through July 1999 (Watkins et al. 2000b), the seasonal distribution of the different species was presented by Watkins et al. (2000c), and the variation in year to year calling by the different species were compared to environmental changes such as those from El Niño (Watkins et al. 2001).

Although little is known from direct observation about the whale populations in the open sea, regular monitoring of their calls makes it possible to assess the occurrence of the portion of these populations that are producing sounds and to judge their attendant behaviors. The non-disturbing, passive listening systems provide year-round, all weather, day and night monitoring of these offshore whales. The calls of the different species are known from previous study and cataloging of their

acoustic behaviors (Watkins and Wartzok 1985, Watkins et al. 1992). Therefore, we can estimate the likely numbers of whales of the various species that would be heard calling in different locations and seasons across the deep waters of the North Pacific.

METHODS

Whale calls in the North Pacific were monitored at the Naval Ocean Processing Facility on Whidbey Is., WA. Acoustic data from deep water hydrophone arrays of the SOSUS system and other hydrophone arrays have been sampled on a regular schedule to assess the occurrence of particular whale calls. Whale calls were identified by analysts experienced in recognition of the different whale call patterns. Ten bottom arrays were selected as providing representative data for four offshore Regions along the continental margins, labeled Northwest (NW), Northcentral (NC), Northeast (NE), and Southeast (SE). The Regions were divided at increments of 30° Longitude by 15° Latitude, see Figure 1.

Within these Regions, north-south detail was provided by the

use of two or three arrays at different latitudes. Two arrays were used in each of the NW and NC Regions, and three arrays in each of the NE and SE Regions. Individual arrays within Regions were labeled from the north (SE1 north of SE2 in SE, etc.). Beam-formed data from each hydrophone array were interpolated to give the equivalent of 40 line array beams for each array. This provided comparable information from all array systems, regardless of their composition. Array orientations were not considered for these analyses. Locations for many of the Navy hydrophone systems have remained protected, along with their characteristics and associated data processing.

Typically, there was no overlap in the calls from local whales recorded by the different arrays within Regions. When competing noise was absent, calls from very distant whales sometimes could be noted, but these normally were not a component of the primary call occurrence data. Counts of calling whales were tabulated separately for each array. The spectrographic data from all arrays were examined systematically over the same period during two, usually consecutive, 16-hour days every week, centered on 1200 hours GMT. This period spanned both daylight and darkness in each

Region. The calls of one to five whales of the same species distinguished on the same beam, generally within a period of about four hours, were considered one call occurrence event. No new occurrences were logged for that beam during that day, unless it was obvious that another set of calls had begun from markedly different whales (distinct difference in level and acoustic pattern). Whale call sequences often continued over much of the day, and therefore, were recorded as one occurrence. If similar call sequences were present on the same array beam on the second day, they were recorded as another occurrence. One dominant beam displaying the calls was identified for each call occurrence. Changes over time in the distribution of calling individuals and local groups of whales across different array beams showed the extent of their movements, over days or weeks.

COUNTS OF CALLING WHALES

Judgements as to the numbers of whales heard calling in these data were based on the previous experience with these continuing observations of calling whales (5 1/2 years to date). Each array beam represented a different direction to the source of incoming sound. In addition, there often were several whales calling from different local areas, and from different distances in the same direction.

To provide a realistic count the number of whales heard from each direction, relatively large amounts of data and considerable familiarity with the spectral representations of the whale sounds as well as noise patterns have been needed. It was anticipated that such estimates would be refined with continuing analyses of the call data. The counts of calling whales enumerated here represented assessments of the numbers of whales heard, the numbers of overlapping call sequences from different relatively local whales audible from the same direction for each calling event.

Call patterns for each whale species were consistently different, so that species distinctions could be made reliably (each with different repetition patterns, fundamental frequencies, harmonic sequences, and spectral ranges). Overlapping calls from several whales of the same species were common because of the broad distribution of blue whales and the clumped groups of fin and humpback whales. The counts of calling whales were different for each species, and they varied with season and Region.

Review of the call data to date confirm the number of whales that could be identified when calls were noted. These counts of calling whales were compared and averaged over each month, and then related to the seasonal variations in each Region. Whale calling seasons were offset consistently from the calendar year by one month, matching the apparent annual cycle of call occurrence for each species -- Spring (March - May), Summer (June - August), Fall (September - November), and Winter (December - February) (Watkins et al. 2000b).

For the comparisons presented here, monthly counts of the numbers of calling whales for each of the ten arrays in the four Regions were summed for each season and compared, season by season.

WHALES SPECIES MONITORED

Three species of whales were monitored systematically: blue whale (*Balaenoptera musculus*) and fin whale (*Balaenoptera physalus*) calls, as well as songs from humpback whales (*Megaptera novaeangliae*). Each species had different amounts of calling and variations in seasonal occurrences in each of the four Regions and local areas monitored by separate arrays.

BLUE_WHALE call sequences identified in the acoustic data were their long series of repetitive, downswept tonal calls (cf. Cummings and Thompson 1971, Rivers 1997). These calls usually had fundamental frequencies below 19 Hz and had several harmonics. Calls were repeated variably at 3 to 10 min intervals, often continuing over several hours. Shorter calls and call series from this species were not consistently separable from noise, and so they were not a part of these analyses.

Blue whale calls during their Fall peak calling season usually were from three to eight or more whales during each calling event, averaging five whales for each calling event, and often from too many whales to separate. During Winter, as blue whale calls waned, calling was from one to three whales. Then, in Spring, their lowest calling season, only one whale usually was evident for each calling event. During the Summer, as calling increased again, one to three whales were audible. Therefore, for seasonal comparisons of the numbers of calling whales, Fall calling events were multiplied by 5, Winter by 1.5, Spring by 1, and Summer by 1.5.

FIN WHALE call sequences identified in the acoustic data were the repetitive, downswept "20 Hz" pulse series (cf. Watkins 1981, Watkins et al. 1987). These calls had most energy near 20 Hz, with little harmonic energy. Calls were composed of pulses of about 1 sec each, repeated regularly at rates of a few seconds in characteristic temporal patterns over periods of a few hours to a day or more. Other call types and shorter call sequences from this species were not as easily separated from noise, and were not a part of these analyses. Fin whale calls identified here included those that could be reliably distinguished as coming from individuals (labeled "F") and overlapping concentrations of calls from too many whales in a local area to allow separation (labeled "J"). When present, this "J" call component swamped concurrent "F" calls by individual whales, unless F calls were relatively close to arrays.

Individual fin whale calling (F calls) during the Winter season of peak calling usually was from one to five whales per event, averaging three fin whales calling at a time. During the intermediate Spring and Fall calling seasons, calls were from

one to three whales, and in the Summer period of lowest fin whale calling, only one whale was evident during most calling events. The "J" calls by fin whales, however, regardless of season, were judged to be from six to very many more fin whales. Combining the "F" and "J" calls likely provided the best assessment of the numbers of calling fin whales. Therefore, for seasonal comparisons of the numbers of calling fin whales, F calls and J calls were tabulated separately. For F calls, Winter calling events were multiplied by 3, Spring and Fall events by 1.5, and Summer by 1. The J calling events from fin whales, regardless of season, were multiplied by 6. The totals for the two call types were then added to provide the seasonal assessments of numbers of calling fin whales for each array.

HUMPBACK WHALE song could be recognized reliably, although only the frequencies below a few hundred Hertz were typically received from more distant whales (cf. Payne and McVay 1971, Payne et al. 1983). Songs were heard usually from groups of humpbacks, estimated at three or more individuals singing during each event. Singing typically lasted for several hours, and

usually was related to migration, even when whales remained in the area. Humpback singing events were multiplied by 3.

Individual calling whales of each of these species were likely to be associated with many more whales. Little is known of the number of calling individuals that normally associate in whale groups, or of the number of whales that accompany each calling whale of each species. Most such observations have been of inshore populations of these species which may have quite different patterns of activity compared to the offshore whales.

SEASONAL NUMBERS OF CALLING WHALES

The counts of calling blue, and fin whales, and singing humpback whales have been listed and plotted to provide seasonal comparisons for the different arrays in each Region. The counts of calling whales were tabulated for each of the three-month seasons for each array in the separate Regions: (1) the sum of the "actual" calling events for the three months, and (2) these seasonal counts multiplied by the average number of calling whales noted for each season. The "actual" call event count multiplied by the numbers of calling whales gave realistic numbers of calling whales of each species that occurred

seasonally in the different areas of each Region. See Tables 1-10 for (1) the calling event counts for each array and (2) these event counts multiplied by the seasonal average number of calling whales per event.

These seasonal numbers (event counts multiplied by seasonal averages) are plotted for each species -- blue whales in Figure 2, fin whale F calls in Figure 3, fin whale J calls in Figure 4, fin whale F+J calls in Figure 5, and humpback whale songs in Figure 6. Such counts of sampled calling provide the basis for useful assessments of the numbers of calling blue, fin, and humpback whales present in the different local areas of each of the four North Pacific Regions.

DIFFERENCES IN SEASONAL CALLING

Blue whales were heard most in the NW in the Fall season from whales scattered widely throughout the region. Calling was reduced, but not absent during Spring. The 1998 El Niño year had reduced calling in most areas during the peak Fall season (see Watkins et al. 2001). The NC Region was second in numbers of calling blue whales, and the arrays in the NE Region had the fewest calling whales (Figure 2).

Fin whale calling has had variations that appear related to population behavior, rather than to environmental changes. During the first years of the monitoring program, most fin whales calling during the peak Winter season were in the northern part of the NC Region. However, in 1999 there was a large increase in the numbers of calling fin whales in all Regions (Figures 3-5).

Humpback whale songs were noted most during the first years of monitoring in the SE Region, coincident with the December to May migration between Alaska and southern waters. Songs were also recorded in the NC Region, particularly in the Spring. The NW and NE Regions have had few singing Humpbacks. Then, again in 1999, there was a distinct change in the numbers of calling whales, with fewer whales calling in the SE and many more in the NC Region (Figure 6) -- note the scale change relative to the blue and fin whale figures).

SUMMARY

The numbers of calling whales of each species were derived from (1) the number of call occurrence events recorded for 40 beams of each of the 10 arrays, (2) the sum of these calling events occurring during each of the two 16-hour days sampled very week, (3) the sum of these daily totals for each month, (4) the product of these monthly totals multiplied by the average number of calling whales contributing to each call occurrence event during the month, and (5) the sum of these monthly numbers of calling whales totalled for three months of each season.

These call data draw their utility from the consistent, long-term regularity and comprehensive coverage of the sampling protocol. There have been no supplements for remaining hours of the sampling day, no additions for days not sampled each week, no extensions to compensate for calls not recorded from distant whales, and no extrapolations to accommodate variations in array coverage (180-degree, typical 40-beam pattern assumed). Comparisons of these seasonal numbers of calling whales provided realistic measures of the annual changes in the distribution of the vocalizing components of these offshore

whales. The variations demonstrated the dynamic changes in the seasonal calling -- different for each of the three species and the four Regions. The predictability of call occurrence has become more realistic. The large amount of call data over more than five and a half years of call monitoring have made forecasts of call occurrence more useful.

ACKNOWLEDGMENTS

The whale call monitoring program has enjoyed consistent encouragement and direct participation by Navy Commands and personnel throughout the years of research and analysis at Whidbey Is. Naval Ocean Processing Facility. Previous support for the whale sound program has been from a variety of sources, including the SERDP Council, the Office of Naval Research Marine Mammal Program (N00014-96-1-1130), and the Woods Hole Oceanographic Institution. Current support is from CNO N45 Environmental Program and U.S. Army Corps of Engineers (DCA87-00-H-0026) with funding from the Department of Defense Legacy Resource Management Program. Experienced analysts sharing in the monitoring responsibilities have been Darel Martin, Scott Haga, and David Rodriguez.

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CAPTIONS

(In order of occurrence)

FIGURE 1

Map of North Pacific Regions. NW, NC, NE, and SE Regions were monitored for calling whales.

TABLE 1 - 2

Blue whale calling, actual call occurrence events and totals multiplied by average number of whales calling.

FIGURE 2

Seasonal comparison of numbers of calling blue whales for the different arrays in the four Regions for each year.

TABLES 3 - 4

Fin whale "F" calling, actual call occurrence events and totals multiplied by average number of whales calling.

FIGURE 3

Seasonal comparison of numbers of "F" calling fin whales for the different arrays in the four Regions for each year.

TABLES 5 - 6

Fin whale "J" calling, actual call occurrence events and totals multiplied by average number of whales calling.

FIGURE 4

Seasonal comparison of numbers of "J" calling fin whales for the different arrays in the four Regions for each year.

TABLE 7

Fin whale "F" plus "J" calling, sum of multiplied totals of both types of calls.

FIGURE 5

Seasonal comparison of numbers of combined "F" plus "J" calling fin whales for the different arrays in the four Regions for each year -- sum of multiplied totals.

TABLES 8 - 9

Humpback whale singing, actual song occurrence events and totals multiplied by average number of whales singing.

FIGURE 6

Seasonal comparison of numbers of singing humpback whales for the different arrays in the four Regions for each year.

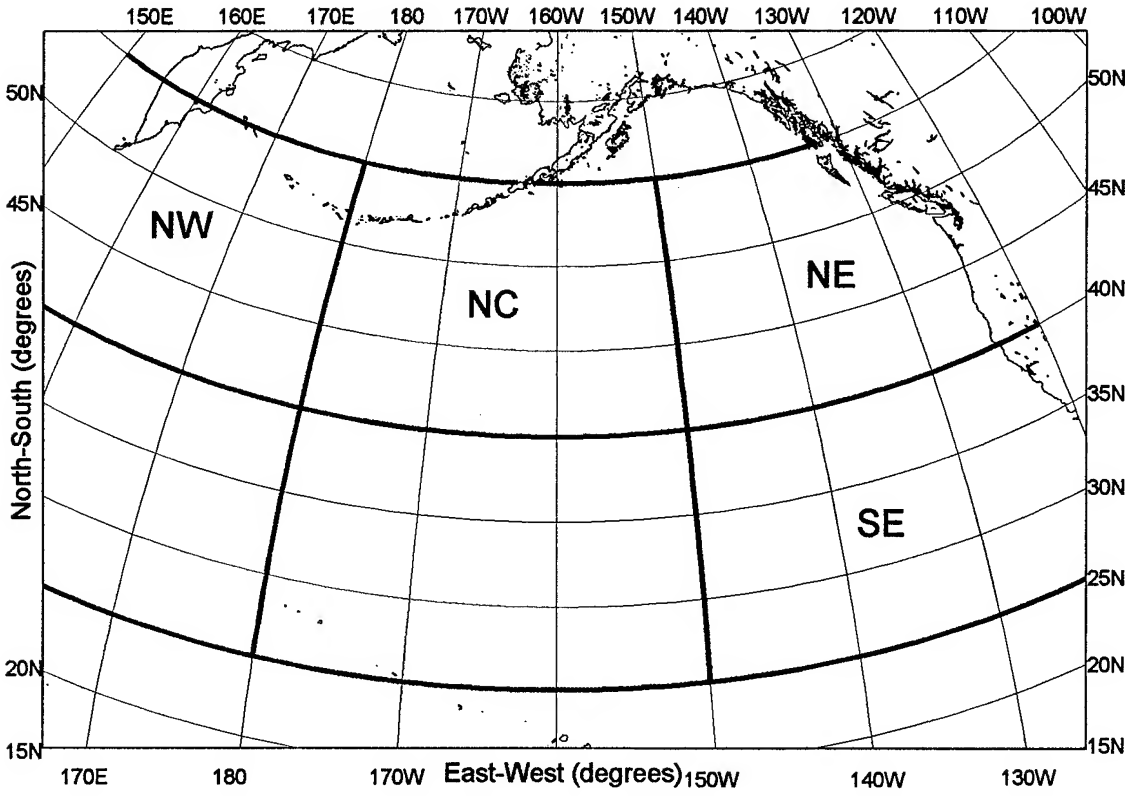
150E
160E
170E
180
170W
160W
150W
140W
130W
120W
110W
100W
50N
45N
40N
35N
30N
25N
20N
15N
NW
NC
NE
SE
North-South (degrees)
170E
180
170W
East-West (degrees)
150W
140W
130W

Fig. 1

Table 1 Blue Whale Totals

	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun
1995	**ACTUAL**	**x1.5**	**ACTUAL**	**x1.5**	**ACTUAL**	**x1**	**ACTUAL**	**x1**	**ACTUAL**	**x1**	**ACTUAL**	**x1.5**
NW1												
NW2												
NC1												
NC2												
NE1												
NE2												
NE3												
SE1												
SE2												
SE3												
1996												
NW1	32	47	13	19	5	5	4	4	5	5	37	56
NW2	73	109	51	76	6	6	5	5	19	19	55	83
NC1	20	29	11	17	12	12	6	6	0	0	2	3
NC2	32	47	42	62	15	15	1	1	7	7	18	26
NE1	12	18	0	0	13	13	0	0	0	0	0	0
NE2	2	3	0	0	0	0	0	0	0	0	8	12
NE3	4	6	16	24	0	0	0	0	0	0	13	20
SE1							0	0	0	0	0	0
SE2							0	0	0	0	0	0
SE3							0	0	0	0	0	0
1997												
NW1	36	54	15	22	22	22	13	13	25	25	42	63
NW2	39	58	10	15	21	21	14	14	33	33	73	110
NC1	33	49	12	18	7	7	5	5	1	1	4	6
NC2	54	81	33	50	20	20	8	8	4	4	11	17
NE1	2	3	0	0	0	0	6	6	0	0	0	0
NE2	16	24	7	11	0	0	0	0	0	0	5	8
NE3	34	51	7	11	0	0	3	3	0	0	6	9
SE1	32	48	3	5	24	24	18	18	18	18	0	0
SE2	36	54	28	42	34	34	6	6	2	2	0	0
SE3	20	30	23	35	36	36	8	8	1	1	3	5
1998												
NW1	60	90	27	41	20	20	8	8	31	31	55	82
NW2	32	48	5	8	4	4	9	9	42	42	98	147
NC1	36	54	20	30	12	12	0	0	1	1	8	12
NC2	99	168	43	64	29	29	6	6	13	13	24	35
NE1	5	8	0	0	0	0	0	0	0	0	0	0
NE2	3	5	0	0	0	0	0	0	0	0	0	0
NE3	15	23	18	27	5	5	0	0	0	0	2	3
SE1	29	44	28	42	26	26	22	22	0	0	21	32
SE2	26	39	78	117	16	16	3	3	2	2	0	0
SE3	52	78	41	62	7	7	0	0	2	2	0	0
1999												
NW1	53	80	20	29	11	11	22	22	22	22	34	50
NW2	61	92	11	16	6	6	28	28	23	23	53	79
NC1	40	60	22	33	12	12	0	0	0	0	16	24
NC2	51	76	45	68	11	11	7	7	9	9	27	41
NE1	3	5	0	0	0	0	0	0	0	0	0	0
NE2	19	29	12	18	0	0	0	0	0	0	0	0
NE3	22	33	15	23	7	7	0	0	0	0	0	0
SE1	60	90	0	0	10	10	0	0	1	1	17	26
SE2	102	153	0	0	37	37	0	0	0	0	0	0
SE3	65	98	0	0	63	63	0	0	1	1	8	12
2000												
NW1	66	99	66	99	17	17	8	8	20	20	59	89
NW2	40	61	16	24	8	8	13	13	19	19	37	56
NC1	43	65	20	30	3	3	0	0	0	0	10	15
NC2	81	122	95	143	26	26	1	1	5	5	20	30
NE1	0	0	6	9	3	3	0	0	0	0	6	9
NE2	12	18	2	3	0	0	0	0	0	0	0	0
NE3	21	32	18	27	7	7	0	0	2	2	0	0
SE1			10	15	33	33	0	0	0	0	0	0
SE2			33	50	51	51	1	1	1	1	0	0
SE3			33	50	27	27	15	15	0	0	2	3
2001												
NW1	60	89	27	41	11	11	0	0	6	6		
NW2	33	50	11	16	10	10	4	4	10	10		
NC1	87	131	78	116	21	21	2	2	8	8		
NC2	83	125	103	154	10	10	4	4	6	6		
NE1	0	0	0	0	0	0	0	0	1	1		
NE2	0	0	0	0	0	0	1	1	0	0		
NE3	34	51	12	18	12	12	2	2	1	1		
SE1	27	41	4	6	45	45	8	8	2	2		
SE2	40	60	37	56	80	80	20	20	0	0		
SE3	148	222	44	66	86	86	18	18	0	0		

Table 2 Blue Whale Totals

	Jul	Jul	Aug	Aug	Sept	Sept	Oct	Oct	Nov	Nov	Dec	Dec
1995	**ACTUAL**	**x1.5**	**ACTUAL**	**x1.5**	**ACTUAL**	**x5**	**ACTUAL**	**x5**	**ACTUAL**	**x5**	**ACTUAL**	**x1.5**
NW1									205	1025	97	145
NW2									107	533	85	127
NC1									86	428	47	71
NC2									91	455	85	127
NE1									21	105	17	26
NE2									11	55	16	24
NE3									61	305	14	21
SE1												
SE2												
SE3												
1996												
NW1	123	184	265	397	341	1705	204	1020	25	125	104	156
NW2	125	187	165	247	261	1305	256	1278	29	145	108	162
NC1	19	29	53	79	64	320	81	405	13	63	56	84
NC2	53	80	140	210	231	1155	116	578	1	5	82	123
NE1	8	12	31	47	0	0	3	15	37	185	0	0
NE2	1	2	31	47	25	125	5	25	14	70	41	62
NE3	21	32	51	77	67	335	46	230	60	300	29	44
SE1	9	14	28	42	55	275	49	245	70	350	103	155
SE2	4	6	28	42	38	190	37	185	44	220	105	158
SE3	17	26	48	72	55	275	50	250	59	295	69	104
1997												
NW1	94	140	273	410	286	1430	262	1308	213	1065	125	188
NW2	121	181	187	281	257	1285	299	1495	226	1128	190	284
NC1	38	57	98	147	75	375	107	535	107	533	65	98
NC2	47	70	174	261	219	1095	260	1300	279	1395	129	194
NE1	2	3	17	26	33	165	30	150	21	105	5	8
NE2	8	12	31	47	50	250	28	140	28	140	4	6
NE3	16	24	63	95	70	350	130	650	96	480	31	47
SE1	31	47	67	101	75	375	102	510	69	345	68	102
SE2	9	14	80	120	76	380	43	215	62	310	61	92
SE3	28	42	83	125	81	405	93	465	88	440	46	69
1998												
NW1	120	180	385	577	245	1225			300	1498	115	173
NW2	158	237	312	468	184	920			176	880	144	216
NC1	44	66	104	156	108	540			110	548	104	155
NC2	56	84	311	467	129	645			139	695	159	238
NE1	0	0	21	32	54	270	34	170	38	190	49	74
NE2	3	5	22	33	21	105	54	270	32	160	18	27
NE3	14	21	54	81	63	315	92	460	77	385	62	93
SE1	28	42	86	129	77	385	123	615	90	450	115	173
SE2	1	2	45	68	47	235	71	355	85	425	95	143
SE3	23	35	61	92	43	215	90	450	105	525	91	137
1999												
NW1	122	183	122	183	428	2140	356	1780	324	1618	227	340
NW2	141	212	141	212	340	1700	274	1370	282	1408	141	212
NC1	59	89	59	89	137	685	102	508	105	523	90	134
NC2	87	131	87	131	209	1045	217	1085	230	1150	224	335
NE1	8	12	8	12	28	140	132	660	21	105	6	9
NE2	0	0	0	0	30	150	7	35	7	35	9	14
NE3	10	15	10	15	63	315	58	290	68	340	38	57
SE1	12	18	12	18	160	800	87	435	35	175		
SE2	12	18	12	18	105	525	43	215	35	175		
SE3	46	69	46	69	121	605	80	400	42	210		
2000												
NW1	141	212	405	608	339	1695	343	1715	390	1948	227	340
NW2	83	125	280	420	247	1235	244	1220	337	1683	199	299
NC1	45	68	106	159	148	740	125	625	223	1115	90	134
NC2	64	95	300	450	210	1050	217	1083	306	1528	224	335
NE1	8	12	16	24	28	140	22	110	24	120	0	0
NE2	5	8	23	35	8	40	3	15	30	150	17	26
NE3	7	11	38	57	105	525	112	560	129	645	113	170
SE1	62	93	144	216	100	500	115	575	167	835	101	152
SE2	19	29	68	102	75	375	122	610	103	515	92	138
SE3	53	80	77	116	94	470	111	555	138	690	113	170

Occurrence of Blue Whale Calls from 1996-2001

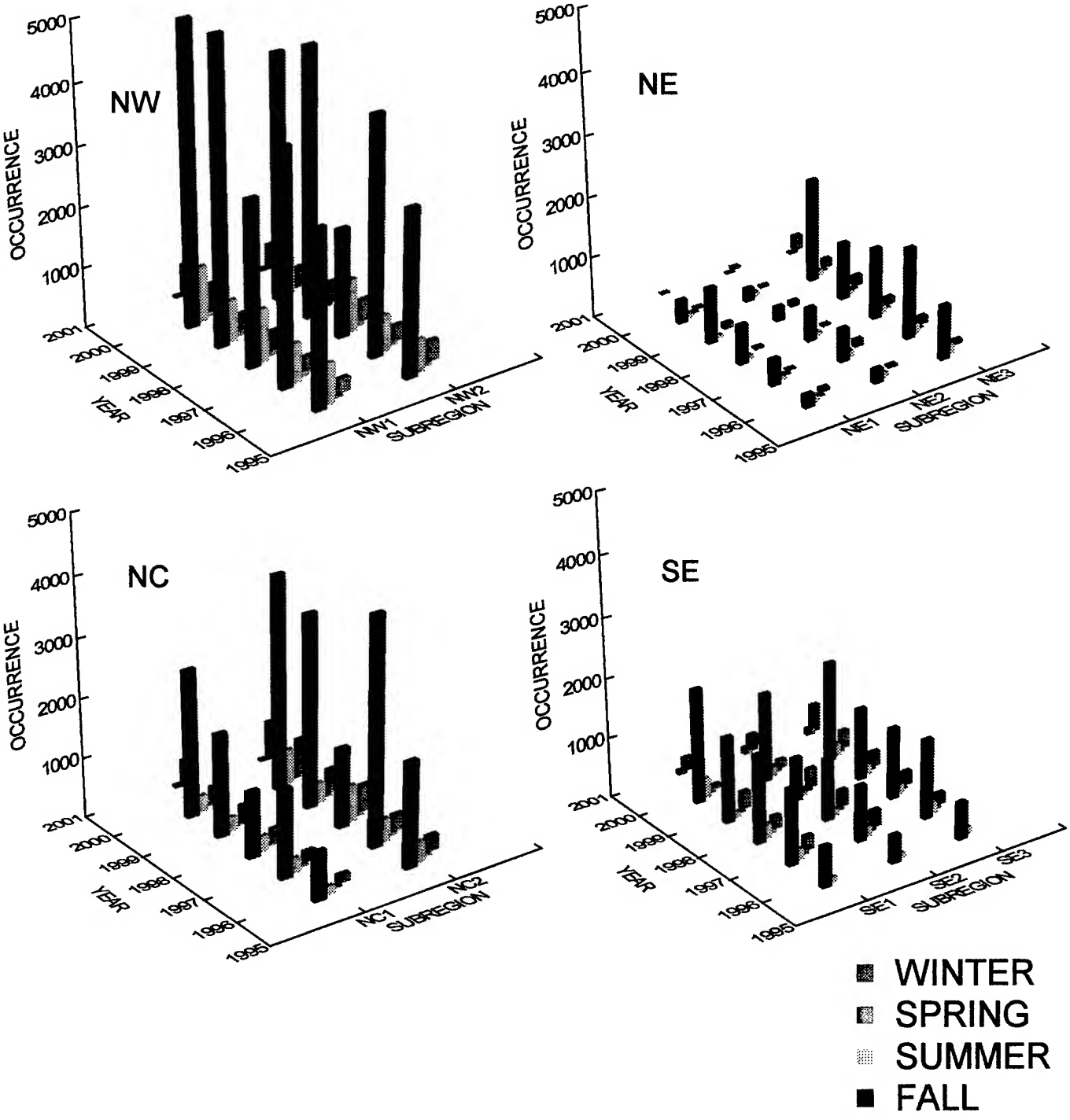

Fig. 2

Table 3 Fin Whale, F, Totals

	Jan	Jan	Feb	Feb	March	March	April	April	May	May	Jun	Jun
1995	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x1.5**	**Actual**	**x1.5**	**Actual**	**x1.5**	**Actual**	**x1**
NW1												
NW2												
NC1												
NC2												
NE1												
NE2												
NE3												
SE1												
SE2												
SE3												
1996												
NW1	11	33	25	75	22	33	8	12	6	9	1	1
NW2	10	30	13	39	23	35	6	9	22	33	2	2
NC1	20	60	8	24	24	36	4	6	0	0	1	1
NC2	2	6	16	48	25	38	2	3	3	5	0	0
NE1	96	288	31	93	24	36	42	63	12	18	0	0
NE2	58	174	40	120	117	176	65	98	7	11	0	0
NE3	9	27	3	9	55	83	40	60	5	8	0	0
SE1									0	0	0	0
SE2									0	0	0	0
SE3									0	0	0	0
1997												
NW1	22	66	30	90	13	20	17	26	0	0	0	0
NW2	55	165	42	126	19	29	32	48	2	3	0	0
NC1	36	108	26	78	17	26	4	6	6	9	7	7
NC2	27	81	21	63	22	33	25	38	0	0	0	0
NE1	113	339	60	180	35	53	11	17	11	17	8	8
NE2	102	306	110	330	129	194	77	116	43	65	2	2
NE3	85	255	67	201	51	77	41	62	13	20	0	0
SE1	74	222	77	231	191	287	106	159	9	14	0	0
SE2	113	339	164	492	69	104	33	50	0	0	2	2
SE3	145	435	191	573	113	170	72	108	11	17	0	0
1998												
NW1	65	195	24	72	14	21	25	37	4	6	0	0
NW2	85	255	38	114	19	29	14	21	22	33	0	0
NC1	53	50	29	87	33	50	2	3	8	12	1	1
NC2	30	90	5	15	21	32	23	34	3	5	0	0
NE1	19	57	33	99	64	96	20	30				
NE2	28	84	19	57	56	84	19	29	2	3	0	0
NE3	34	102	3	9	14	21	58	87	0	0	0	0
SE1	83	249	89	267	106	159	63	95	20	30		
SE2	87	261	132	396	93	140	22	63	0	0	0	0
SE3	130	390	159	477	150	225	45	68	3	5	0	0
1999												
NW1	46	138	37	111	46	69	44	66	7	11	0	0
NW2	86	258	19	57	18	27	17	26	5	8	0	0
NC1	125	375	106	318	89	134	40	60	4	6	2	2
NC2	48	144	15	45	30	45	24	36	0	0	0	0
NE1	105	315	86	258	84	126	42	63	2	3		
NE2	52	156	83	249	49	74	52	78	7	11	2	2
NE3	85	255	49	147	109	164	58	87	2	3	0	0
SE1	276	828	268	804	275	413	92	138	9	14	0	0
SE2	321	963	146	438	126	189	42	63	2	3	0	0
SE3	306	918	407	1221	250	375	234	351	11	17	4	4
2000												
NW1	38	114	56	168	61	91	30	45	9	14	0	0
NW2	25	75	27	81	21	31	13	20	2	3	0	0
NC1	52	156	63	189	86	129	18	27	5	8	3	3
NC2	29	87	11	33	37	56	33	50	1	2	0	0
NE1	21	63	67	201	69	104	31	47	16	24	3	3
NE2	32	96	58	174	71	107	25	38	62	93	4	4
NE3	42	126	56	168	76	114	22	33	15	23	10	10
SE1			309	1127	450	675	134	201	20	30	0	0
SE2			292	876	172	258	59	89	15	23	2	2
SE3			356	1068	551	827	146	219	15	23	6	6
2001												
NW1	55	164	90	270	50	75	6	9	5	8		
NW2	39	117	44	132	24	35	7	10	5	8		
NC1	79	237	115	345	98	147	47	71	6	9		
NC2	36	108	9	26	35	53	9	13	3	5		
NE1	86	258	0	0	206	309	235	353	103	155		
NE2	180	540	0	0	85	128	141	212	38	57		
NE3	118	354	12	36	152	228	146	219	76	114		
SE1	119	357	197	591	371	557	172	258	47	71		
SE2	242	726	99	297	381	572	172	258	53	80		
SE3	249	747	254	762	362	543	252	378	103	155		

Table 4 Fin Whale, F, Totals

	Jul	Jul	Aug	Aug	Sept	Sept	Oct	Oct	Nov	Nov	Dec	Dec
1995	**Actual**	**x1**	**Actual**	**x1**	**Actual**	**x1.5**	**Actual**	**x1.5**	**Actual**	**x1.5**	**Actual**	**x3**
NW1									0	0	4	11
NW2									0	0	12	35
NC1									0	0	3	9
NC2									0	0	0	0
NE1									72	108	62	186
NE2									59	89	33	99
NE3									69	104	26	78
SE1												
SE2												
SE3												
1996												
NW1	1	1	2	2	3	5	19	28	1	2	10	29
NW2	3	3	8	8	30	45	13	19	5	7	13	38
NC1	4	4	0	0	37	56	65	98	3	5	30	90
NC2	1	1	5	5	48	72	21	31	0	0	34	102
NE1	0	0	0	0	69	104	104	156	57	86	37	111
NE2	0	0	7	7	84	126	60	90	150	225	43	129
NE3	2	2	11	11	74	111	123	185	69	104	31	96
SE1	0	0	0	0	1	2	1	2	40	60	77	231
SE2	0	0	0	0	0	0	0	0	15	23	118	354
SE3	0	0	0	0	0	0	4	6	30	45	154	462
1997												
NW1	0	0	15	15	36	54	46	65	32	48	44	132
NW2	3	3	13	13	24	36	39	58	58	87	50	150
NC1	6	6	11	11	20	30	107	160	63	95	41	122
NC2	0	0	20	20	42	63	74	110	38	56	30	90
NE1	5	5	16	16	57	86	29	44	36	54	10	30
NE2	9	9	33	33	90	135	62	93	97	146	12	36
NE3	4	4	40	40	132	198	117	176	106	159	65	195
SE1	0	0	3	3	0	0	10	15	24	36	83	249
SE2	0	0	0	0	0	0	2	3	15	23	49	147
SE3	0	0	0	0	2	3	2	3	25	38	76	228
1998												
NW1	0	0	7	7	59	89			34	51	83	249
NW2	0	0	11	11	38	57			50	74	65	194
NC1	12	12	9	9	47	71			151	226	92	275
NC2	0	0	4	4	34	51			16	34	33	99
NE1	2	2	0	0	9	14	25	38	31	47	27	81
NE2	0	0	0	0	14	21	24	36	30	45	12	36
NE3	0	0	2	2	48	72	97	146	239	359	125	375
SE1	0	0	11	11	6	9	7	11	97	146	220	660
SE2	0	0	0	0	0	0	9	14	66	99	323	969
SE3	0	0	0	0	0	0	14	21	68	102	312	936
1999												
NW1	1	1	9	9	41	62	74	110	40	59	35	105
NW2	0	0	3	3	46	69	79	119	90	134	60	180
NC1	7	7	26	26	108	162	148	221	119	178	43	129
NC2	0	0	6	6	81	122	57	86	44	66	28	84
NE1	3	3	34	34	99	149	49	74	42	63	104	312
NE2	2	2	6	6	14	21	20	30	52	78	54	162
NE3	12	12	56	56	108	162	97	145	121	182	70	210
SE1	9	9	88	88	81	122	51	77	144	216		
SE2	0	0	0	0	6	9	33	50	34	51		
SE3	0	0	0	0	14	21	0	0	144	216		
2000												
NW1	2	2	14	14	43	65	37	55	56	84	61	183
NW2	2	2	27	27	28	42	39	59	172	257	113	339
NC1	6	6	45	45	103	155	133	199	272	407	275	825
NC2	0	0	17	17	46	69	79	118	55	82	58	174
NE1	6	6	58	58	135	203	140	210	258	387	215	645
NE2	5	5	49	49	39	59	92	138	218	327	202	606
NE3	86	86	267	267	127	191	228	342	224	336	215	645
SE1	0	0	19	19	19	29	110	165	149	224	297	891
SE2	2	2	5	5	12	18	25	38	70	105	224	672
SE3	0	0	15	15	20	30	100	150	155	233	198	594

Occurrence of Fin Whale, F, Calls from 1996-2001

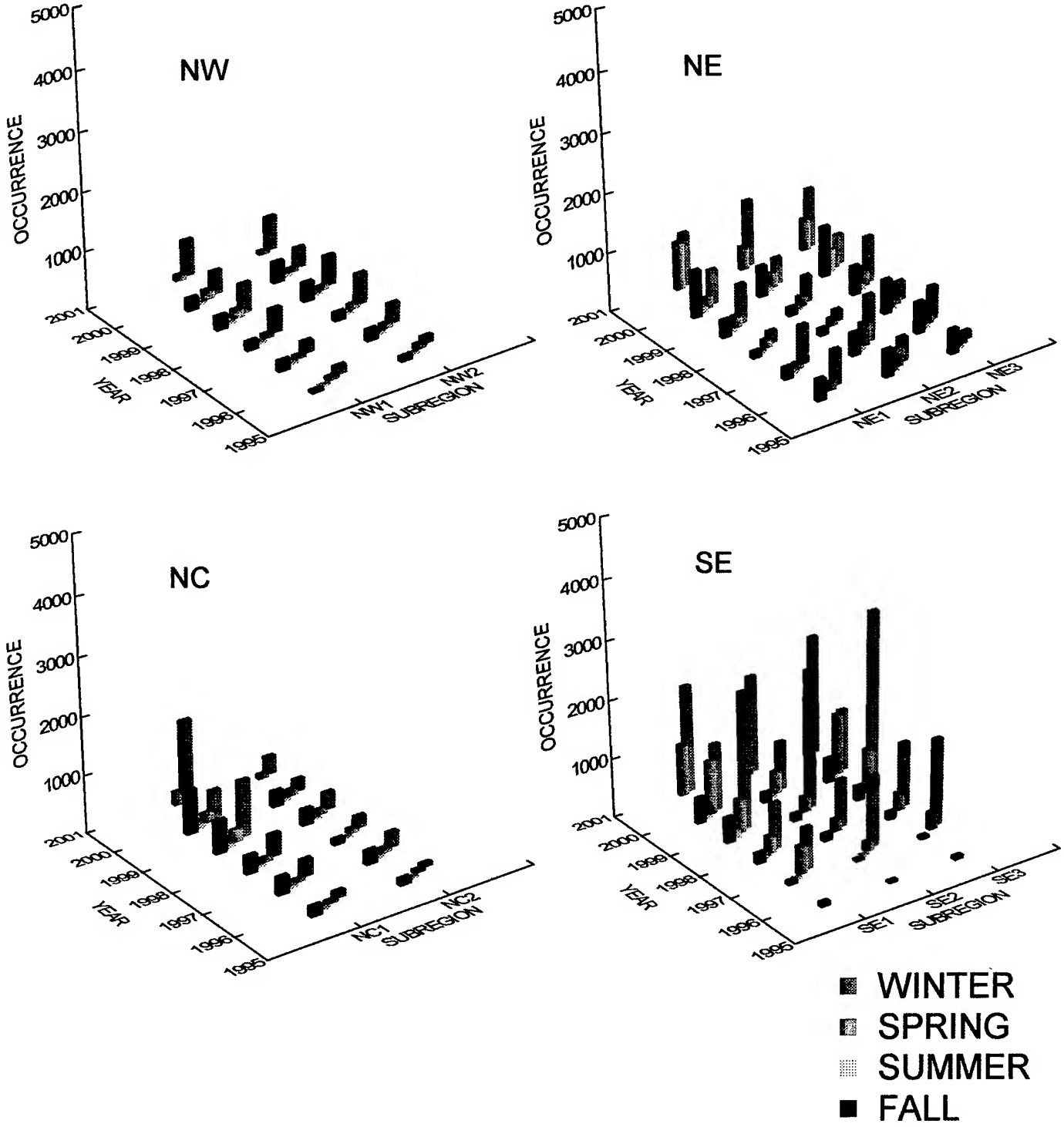

Fig. 3

Table 5

Fin Whale, J, Totals

	Jan	Jan	Feb	Feb	March	March	April	April	May	May	Jun	Jun
1995	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**
NW1												
NW2												
NC1												
NC2												
NE1												
NE2												
NE3												
SE1												
SE2												
SE3												
1996												
NW1	35	210	41	246	11	66	0	0	2	12	0	0
NW2	57	342	35	210	8	48	0	0	0	0	0	0
NC1	175	1050	138	828	43	258	31	186	31	186	29	174
NC2	49	294	31	186	43	258	4	24	0	0	3	18
NE1	23	138	3	18	0	0	0	0	0	0	0	0
NE2	40	240	77	462	0	0	0	0	0	0	0	0
NE3	72	432	47	282	5	30	2	12	0	0	2	12
SE1									0	0	0	0
SE2									0	0	0	0
SE3									0	0	0	0
1997												
NW1	26	156	1	6	7	42	2	12	1	6	0	0
NW2	22	132	3	18	6	36	4	24	4	24	3	18
NC1	47	282	52	312	34	204	32	192	27	162	24	144
NC2	22	132	16	96	8	48	3	18	1	6	1	6
NE1	0	0	0	0	4	24	0	0	0	0	0	0
NE2	3	18	0	0	3	18	0	0	9	54	11	66
NE3	6	36	2	12	2	12	28	168	18	108	6	36
SE1	50	300	4	24	6	24	0	0	0	0	0	0
SE2	25	150	26	156	8	48	0	0	0	0	0	0
SE3	6	36	0	0	10	60	3	18	0	0	0	0
1998												
NW1	10	60	8	48	7	42	2	12	0	0	0	0
NW2	21	126	14	84	11	66	1	6	0	0	0	0
NC1	67	402	74	444	46	276	26	156	25	150	23	138
NC2	35	210	62	372	47	282	2	12	0	0	0	0
NE1	4	24	0	0	0	0	0	0	0	0	0	0
NE2	2	12	16	96	3	18	5	30	13	78	0	0
NE3	44	264	9	54	49	294	33	198	20	120	10	60
SE1	18	108	0	0	4	24	5	30	0	0	0	0
SE2	35	210	3	18	11	66	3	18	0	0	0	0
SE3	19	114	0	0	0	0	0	0	0	0	0	0
1999												
NW1	18	108	10	60	15	90	22	132	0	0	0	0
NW2	4	24	9	54	12	72	16	96	0	0	0	0
NC1	57	342	54	324	28	168	74	444	25	150	26	156
NC2	43	258	17	102	12	72	30	180	3	18	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	14	84	11	66	7	42	0	0	2	12	0	0
NE3	40	240	84	504	35	210	72	432	14	84	5	30
SE1	20	120	65	390	37	222	48	288	0	0	0	0
SE2	45	270	106	636	75	450	18	108	0	0	0	0
SE3	12	72	35	210	56	336	36	216	0	0	4	24
2000												
NW1	69	414	34	204	25	150	3	18	1	6	0	0
NW2	57	342	43	258	6	36	2	12	0	0	0	0
NC1	170	1020	126	756	82	492	43	258	52	312	34	204
NC2	39	234	54	324	11	66	0	0	2	12	0	0
NE1	20	120	6	36	16	96	5	30	4	24	0	0
NE2	111	666	52	312	61	366	0	0	3	18	0	0
NE3	150	900	158	948	108	648	22	132	12	72	4	24
SE1			0	0	0	0	0	0	0	0	0	0
SE2			0	0	10	60	0	0	0	0	0	0
SE3			0	0	0	0	0	0	0	0	0	0
2001												
NW1	78	465	91	543	33	195	3	150	9	54		
NW2	111	666	30	177	40	240	5	30	3	18		
NC1	128	765	159	954	73	435	45	267	36	216		
NC2	58	345	154	921	93	555	7	39	2	12		
NE1	205	1230	61	366	19	114	7	42	0	0		
NE2	208	1248	80	480	58	348	27	162	21	126		
NE3	204	1224	83	498	45	270	26	156	23	812		
SE1	149	894	69	414	10	60	40	240	90	540		
SE2	120	720	186	1116	18	108	47	282	12	72		
SE3	78	468	85	510	17	102	70	420	13	78		

Table 6

Fin Whale, J, Totals

	Jul	Jul	Aug	Aug	Sept	Sept	Oct	Oct	Nov	Nov	Dec	Dec
1995	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**	**Actual**	**x6**
NW1									50	300	115	690
NW2									9	54	90	540
NC1									10	60	187	1122
NC2									14	84	93	558
NE1									0	0	11	66
NE2									4	24	79	474
NE3									22	132	173	1038
SE1												
SE2												
SE3												
1996												
NW1	0	0	0	0	0	0	0	0	6	36	75	450
NW2	0	0	0	0	8	48	1	6	0	0	75	450
NC1	10	60	0	0	39	234	122	732	30	180	214	1284
NC2	0	0	0	0	5	30	6	18	0	0	79	474
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	10	60	23	138	43	258	64	384
NE3	0	0	0	0	0	0	3	18	31	186	173	1038
SE1	0	0	0	0	13	78	22	132	54	324	93	558
SE2	0	0	0	0	2	12	33	198	63	378	61	366
SE3	0	0	0	0	12	72	53	318	66	396	91	546
1997												
NW1	0	0	0	0	0	0	13	78	16	96	31	186
NW2	3	18	0	0	0	0	0	0	19	114	11	66
NC1	27	162	19	114	21	126	60	360	117	702	79	474
NC2	0	0	0	0	0	0	17	102	10	60	79	474
NE1	0	0	0	0	0	0	0	0	0	0	3	18
NE2	0	0	0	0	0	0	37	222	6	36	11	66
NE3	0	0	2	12	6	36	14	84	2	12	10	60
SE1	2	12	3	18	18	108	4	24	11	66	17	102
SE2	0	0	0	0	0	0	21	126	13	78	43	258
SE3	0	0	0	0	7	42	51	306	30	180	10	60
1998												
NW1	0	0	0	0	0	0	0	0	29	174	51	306
NW2	0	0	0	0	0	0	0	0	31	186	55	330
NC1	10	60	8	48	3	18	0	0	104	624	0	0
NC2	0	0	0	0	0	0	0	0	55	330	121	726
NE1	2	12	0	0	0	0	3	18	6	36	0	0
NE2	0	0	0	0	2	12	13	78	59	354	85	510
NE3	10	60	0	0	13	78	3	18	8	48	37	222
SE1	0	0	0	0	0	0	20	120	39	234	101	606
SE2	0	0	8	48	0	0	27	162	48	288	47	282
SE3	0	0	0	0	0	0	16	96	59	354	42	252
1999												
NW1	0	0	0	0	2	12	16	96	71	426	129	774
NW2	0	0	0	0	0	0	22	129	22	129	125	750
NC1	16	96	8	48	41	246	98	588	115	687	223	1338
NC2	0	0	0	0	5	30	51	306	57	342	73	438
NE1	0	0	0	0	0	0	1	6	0	0	97	582
NE2	0	0	0	0	26	156	38	228	86	516	132	792
NE3	3	18	20	120	64	384	29	174	105	630	181	1086
SE1	0	0	9	54	41	246	66	396	17	102		
SE2	0	0	0	0	34	204	27	162	30	180		
SE3	0	0	0	0	44	264	107	642	0	0		
2000												
NW1	0	0	0	0	0	0	3	15	2	9	5	30
NW2	0	0	0	0	0	0	0	0	0	0	28	165
NC1	28	168	35	210	26	156	37	219	93	555	29	174
NC2	2	12	6	6	0	0	0	0	0	0	9	51
NE1	0	0	22	132	0	0	7	42	178	1068	176	1056
NE2	0	0	0	0	16	96	61	366	241	1446	220	1320
NE3	14	84	3	18	0	0	12	72	147	882	115	690
SE1	0	0	13	78	6	36	31	186	55	330	80	480
SE2	0	0	10	60	13	78	57	342	88	528	102	612
SE3	0	0	13	78	9	54	43	258	42	252	113	678

Table 7 Fin Whale, J and F, Totals

	Jan	Feb	March	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1995	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**	**F J Totals**
NW1											300	701
NW2											54	575
NC1											60	1131
NC2											84	558
NE1											108	252
NE2											113	573
NE3											236	1116
SE1												
SE2												
SE3												
1996												
NW1	243	321	99	12	21	1	1	2	5	28	38	479
NW2	372	249	83	9	33	2	3	8	93	25	7	488
NC1	1100	852	294	192	186	175	64	0	290	830	185	1374
NC2	300	234	296	27	5	18	1	5	102	49	0	576
NE1	426	111	36	63	18	0	0	0	104	156	86	111
NE2	414	582	176	98	11	0	0	7	186	228	483	513
NE3	459	291	113	72	8	12	2	11	111	203	290	1134
SE1									80	134	384	789
SE2									12	198	401	720
SE3									72	324	441	1008
1997												
NW1	222	96	62	38	6	0	0	15	54	143	144	318
NW2	297	144	65	72	27	18	21	13	36	58	201	216
NC1	390	390	230	198	171	151	168	125	156	520	797	596
NC2	213	159	81	56	6	6	0	20	63	212	116	564
NE1	339	180	77	17	17	8	5	16	86	44	54	48
NE2	324	330	212	116	119	68	9	33	135	315	182	102
NE3	291	213	89	230	128	36	4	52	234	260	171	255
SE1	522	255	311	159	14	0	12	21	108	39	102	351
SE2	489	648	152	50	0	2	0	0	0	129	101	405
SE3	471	573	230	126	17	0	0	0	45	309	218	288
1998												
NW1	255	120	63	49	6	0	0	7	89		225	555
NW2	381	198	95	27	33	0	0	11	57		260	524
NC1	452	531	326	159	162	139	72	57	89		850	275
NC2	300	387	314	46	5	0	0	4	51		364	825
NE1	81	99	96	30	0	0	14	0	14	56	83	81
NE2	96	153	102	59	81	0	0	0	33	114	399	546
NE3	366	63	315	285	120	60	60	2	150	164	407	597
SE1	357	267	183	125	30	0	0	11	9	131	380	1266
SE2	471	414	206	81	0	0	0	48	0	176	387	1251
SE3	504	477	225	68	5	0	0	0	0	117	456	1188
1999												
NW1	246	171	159	198	11	0	1	9	74	206	485	879
NW2	282	111	99	122	8	0	0	3	69	248	263	930
NC1	717	642	302	504	156	158	103	74	408	809	865	1467
NC2	402	147	117	216	18	0	0	6	152	392	408	522
NE1	315	258	126	63	3	0	3	34	149	80	63	894
NE2	240	315	116	78	23	2	2	6	177	258	594	954
NE3	495	651	374	519	87	30	30	176	546	319	812	1296
SE1	948	1194	635	426	14	0	9	142	368	473	318	
SE2	1233	1074	639	171	3	0	0	0	213	212	231	
SE3	990	1431	711	567	17	24	0	0	285	642	216	
2000												
NW1	528	372	241	63	20	0	2	14	65	70	93	213
NW2	417	339	67	32	3	0	2	27	42	59	257	504
NC1	1176	945	621	285	320	207	174	255	311	418	962	999
NC2	321	357	122	50	14	0	12	23	69	118	82	225
NE1	183	237	200	77	48	3	6	190	203	252	1455	1701
NE2	762	486	473	38	111	4	5	49	155	504	1773	1926
NE3	1026	1116	762	165	95	34	170	285	191	414	1218	1335
SE1		1127	675	201	30	0	0	97	65	351	554	1371
SE2		876	318	89	23	2	2	65	96	380	633	1284
SE3		1068	827	219	23	6	0	93	84	408	485	1272
2001												
NW1	629	813	270	159	62							
NW2	783	309	275	40	26							
NC1	1002	1299	582	338	225							
NC2	453	947	608	52	17							
NE1	1488	366	423	395	155							
NE2	1788	480	476	374	183							
NE3	1578	534	498	375	926							
SE1	1251	1005	617	498	611							
SE2	1446	1413	680	540	152							
SE3	1215	1272	645	798	233							

Occurrence of Fin Whale, F and J, Calls from 1996-2001

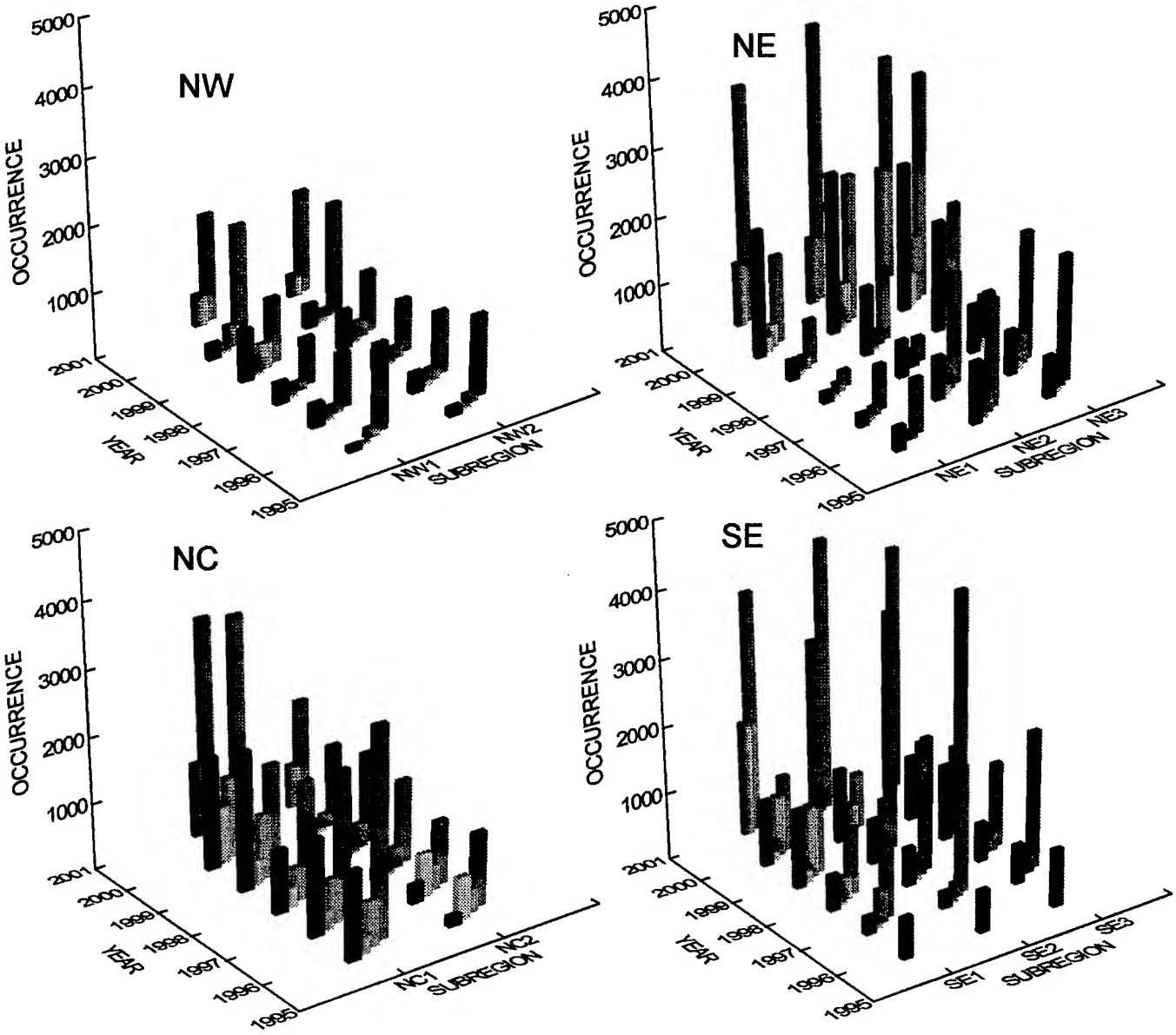

Fig. 5

Table 8 Humpback Whale Totals

	Jan	Jan	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun
1996	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**
NW1	0	0	2	6	0	0	0	0	0	0	0	0
NW2	0	0	0	0	0	0	0	0	0	0	0	0
NC1	0	0	1	3	0	0	6	18	61	183	15	45
NC2	0	0	0	0	0	0	0	0	0	0	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	0	0	0	0	2	6	0	0
NE3	0	0	0	0	0	0	0	0	1	3	0	0
SE1							1	3	33	99	0	0
SE2							150	450	115	145	0	0
SE3							195	585	151	453	0	0
1997												
NW1	1	3	1	3	0	0	0	0	0	0	0	0
NW2	0	0	1	3	0	0	0	0	0	0	0	0
NC1	76	228	4	12	1	3	14	42	37	111	8	24
NC2	2	6	3	9	0	0	0	0	0	0	0	0
NE1	3	9	0	0	0	0	0	0	0	0	0	0
NE2	5	15	0	0	0	0	0	0	0	0	0	0
NE3	2	6	2	6	0	0	0	0	0	0	0	0
SE1	6	18	1	3	0	0	2	6	6	18	0	0
SE2	100	300	39	117	13	39	95	285	20	60	20	60
SE3	166	498	99	297	12	36	44	132	18	54	0	0
1998												
NW1	5	15	0	0	0	0	0	0	0	0	0	0
NW2	4	12	3	9	0	0	0	0	0	0	0	0
NC1	83	249	38	114	0	0	1	3	2	6	1	3
NC2	0	0	1	3	0	0	2	6	0	0	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	1	3	0	0	0	0	0	0	0	0	0	0
NE3	20	60	0	0	0	0	0	0	0	0	0	0
SE1	36	108	6	18	0	0	5	15	2	6	0	0
SE2	188	564	79	237	90	270	53	159	1	3	1	3
SE3	177	531	120	360	83	249	12	36	1	3	0	0
1999												
NW1	9	27	0	0	0	0	0	0	0	0	0	0
NW2	15	45	0	0	0	0	0	0	0	0	0	0
NC1	37	111	5	15	0	0	38	114	40	120	4	12
NC2	9	27	2	6	0	0	2	6	0	0	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	0	0	0	0	0	0	0	0
NE3	20	60	0	0	0	0	0	0	0	0	0	0
SE1	35	105	0	0	0	0	0	0	0	0	0	0
SE2	21	63	15	45	7	21	4	12	0	0	0	0
SE3	35	105	45	135	6	18	0	0	2	6	0	0
2000												
NW1	4	12	3	9	0	0	0	0	0	0	0	0
NW2	0	0	5	15	0	0	0	0	0	0	0	0
NC1	48	144	83	249	0	0	8	24	55	165	19	57
NC2	3	9	4	12	8	24	0	0	2	6	1	3
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	1	3	0	0	0	0	0	0	0	0	0	0
NE3	9	27	11	33	0	0	0	0	0	0	0	0
SE1			8	24	2	6	1	3	0	0	0	0
SE2			19	57	0	0	5	15	0	0	0	0
SE3			45	135	69	207	7	21	0	0	0	0
2001												
NW1	7	20	1	3	0	0	0	0	1	3		
NW2	3	3	0	0	0	0	0	0	0	0		
NC1	142	435	24	72	0	0	49	146	271	813		
NC2	3	9	1	2	0	0	0	0	0	0		
NE1	0	0	0	0	0	0	0	0	0	0		
NE2	0	0	0	0	0	0	0	0	0	0		
NE3	41	123	12	36	1	3	0	0	0	0		
SE1	23	69	6	18	35	105	0	0	6	18		
SE2	36	108	4	12	54	162	6	18	44	132		
SE3	35	105	39	117	38	114	0	0	2	6		

Table 9

Humpback Whale Totals

	Jul	Jul	Aug	Aug	Sept	Sept	Oct	Oct	Nov	Nov	Dec	Dec
1996	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**	**Actual**	**x3**
NW1	0	0	1	3	0	0	0	0	0	0	2	6
NW2	0	0	0	0	0	0	0	0	0	0	0	0
NC1	1	3	0	0	1	3	0	0	1	3	31	93
NC2	0	0	0	0	0	0	0	0	0	0	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	0	0	0	0	0	0	0	0
NE3	0	0	0	0	0	0	0	0	1	3	0	0
SE1	0	0	0	0	0	0	0	0	0	0	0	0
SE2	0	0	0	0	0	0	0	0	0	0	0	0
SE3	0	0	0	0	0	0	0	0	0	0	0	0
1997												
NW1	0	0	0	0	0	0	0	0	0	0	1	3
NW2	0	0	0	0	0	0	0	0	0	0	4	12
NC1	1	3	0	0	0	0	0	0	1	3	27	81
NC2	0	0	0	0	1	3	0	0	0	0	1	3
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	0	0	0	0	0	0	9	27
NE3	0	0	0	0	0	0	0	0	28	84	18	54
SE1	0	0	0	0	0	0	0	0	0	0	0	0
SE2	0	0	0	0	0	0	0	0	0	0	0	0
SE3	0	0	0	0	0	0	0	0	0	0	0	0
1998												
NW1	0	0	0	0	0	0	0	0	0	0	0	0
NW2	0	0	0	0	0	0	0	0	0	0	0	0
NC1	1	3	0	0	0	0	0	0	1	3	25	75
NC2	0	0	0	0	0	0	0	0	0	0	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	0	0	0	0	5	15	13	39
NE3	0	0	0	0	0	0	0	0	33	99	20	60
SE1	0	0	0	0	0	0	0	0	0	0	0	0
SE2	0	0	0	0	0	0	0	0	0	0	0	0
SE3	0	0	0	0	0	0	0	0	0	0	0	0
1999												
NW1	1	3	0	0	0	0	0	0	0	0	4	11
NW2	1	3	0	0	0	0	0	0	0	0	0	0
NC1	1	3	0	0	3	9	11	33	40	120	79	237
NC2	0	0	0	0	0	0	14	41	0	0	1	3
NE1	0	0	0	0	0	0	18	54	3	9	8	24
NE2	0	0	0	0	0	0	0	0	0	0	0	0
NE3	0	0	0	0	0	0	0	0	1	3	3	9
SE1	0	0	0	0	0	0	0	0	0	0		
SE2	0	0	0	0	0	0	0	0	0	0		
SE3	0	0	0	0	0	0	0	0	0	0		
2000												
NW1	0	0	0	0	0	0	2	6	3	8	0	0
NW2	0	0	0	0	0	0	6	18	0	0	0	0
NC1	1	3	2	6	11	33	91	273	161	483	128	384
NC2	0	0	0	0	0	0	17	50	0	0	0	0
NE1	0	0	0	0	0	0	0	0	0	0	0	0
NE2	0	0	0	0	0	0	0	0	0	0	0	0
NE3	0	0	0	0	0	0	1	3	1	3	20	60
SE1	0	0	0	0	0	0	0	0	0	0	8	24
SE2	0	0	0	0	0	0	0	0	0	0	0	0
SE3	0	0	0	0	0	0	0	0	5	15	0	0

Occurrence of Humpback Whale Calls from 1996-2001

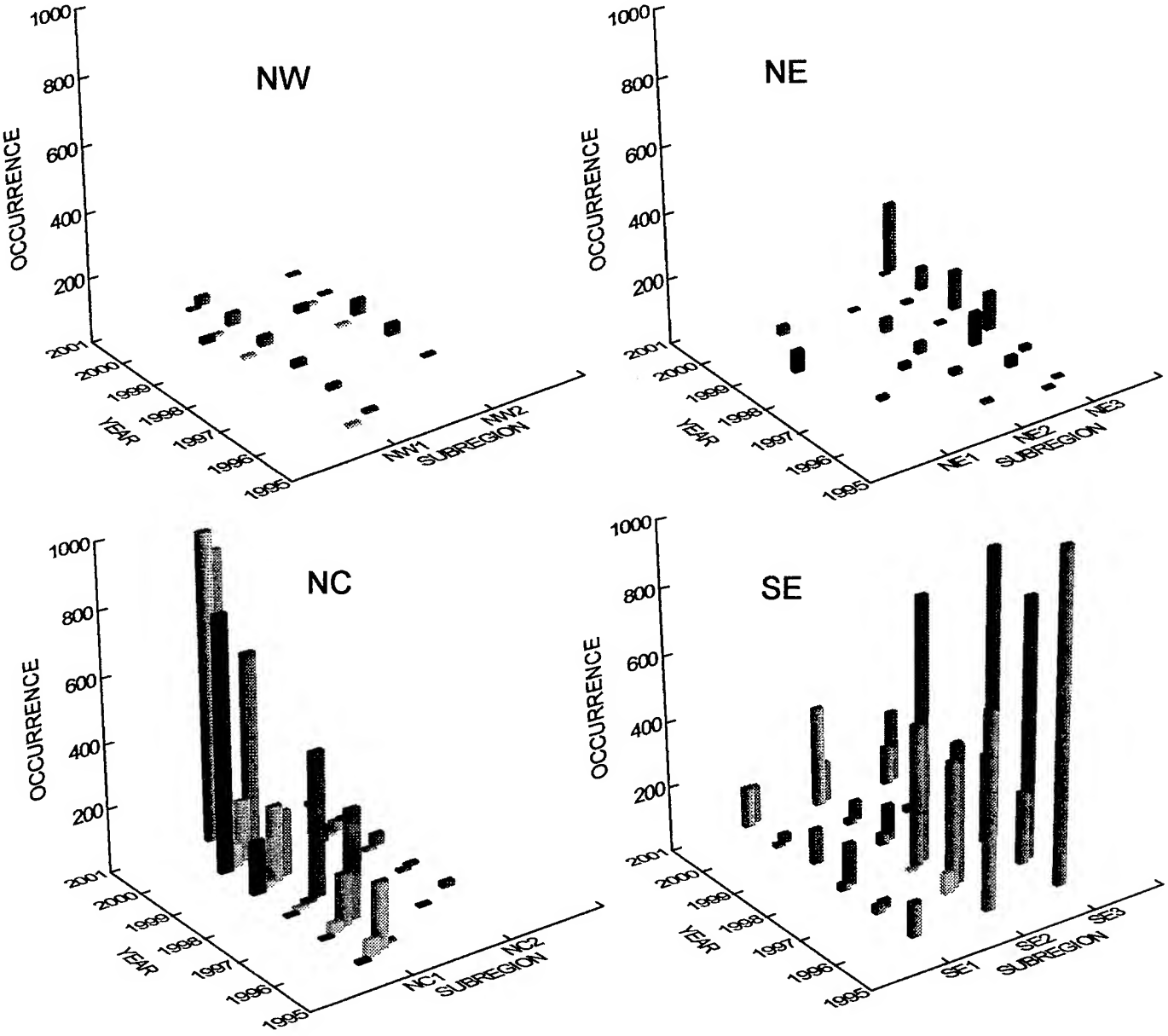

Fig. 6

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Since November 1995, the U.S. Navy's Sound Surveillance System (SOSUS) and other hydrophone arrays were used to regularly sample the occurrence of whale sounds in four regions bordering the continental margins across the North Pacific. The numbers of whales heard calling varied with season and location for each species, blue whales (Balaenoptera musculus), fin whales (Balaenoptera physalus), and humpback whales (Megaptera novaeangliae). For blue whales, calling during the fall season averaged 5 whales per event, winter averaged 1.5 whales per event, spring averaged 1 whale, and summer averaged 1.5 whales. For fin whales the numbers of whales heard ("F" calls from individuals) during winter averaged 3 whales per event, spring and fall calling averaged 1.5 whales, and summer averaged 1 whale. The "J" calling events, regardless of season, were judged to be from at least 6 fin whales. Humpback singing typically was from 3 whales. These number demonstrated seasonal variations in calling whales for each region.

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